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Atmospheric Measurement Techniques Discussions

# *Interactive comment on* "Mind-the-gap Part II: Improving quantitative estimates of cloud and rain water path in oceanic warm rain using spaceborne radars" *by* Alessandro Battaglia et al.

**Matthew Lebsock (Referee)**

matthew.d.lebsock@jpl.nasa.gov

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GENERAL COMMENTS:

This paper is a timely study of the importance of integral constraints (Brightness temperature and path integrated attenuation) on the retrieval of cloud and rain liquid water path in warm rain. This paper is highly relevant to the NASA A/CCP mission pre-formulation activities which are ongoing and considering the effect of PIA/Tb on retrieval capabilities. Important insights into the effects of non-uniform-beam-filling in particular are shown. In particular the capability of along track oversampling to remove bias from the integral constraints is discussed.



The analysis method is appropriate. A couple of citations need to be added and some minor caveats need to be pointed out as described below.

SPECIFIC COMMENTS:

Lebsock and Suzuki, 2016 looked in detail at the ability of W-band PIA and Tb to constrain total water path in warm precipitation in a very similar study you should cite. https://doi.org/10.1175/JTECH-D-16-0023.1

page 8, line 10: Nothing is guaranteed. I would change the 'will' to 'must' or 'should'

page 9, line 5: 'Interestingly, TBs seem to react quicker than the PIA to the presence of the rain cells'. It is not really clear what this means. Do you mean quicker in terms of the Tb signal is larger than the PIA signal? In this case the quantity of interest is the sensitivity divided by the noise in each observation. Or do you mean responding quicker spatially along track? In this case be aware that the CloudSat Tb (as reported) has been averaged using a 5 pixel boxcar window so it has a resolution different than that of the PIA.

Page 10, line 16: The Marshall-Palmer isn't the best assumption for RICO rain. It will really overestimate drop size for a given rain water content. See for example Snodgrass (2009). This will cause you to overestimate the PIA and Tb enhancement so the signal will appear larger than it is likely to be in reality. At the least this caveat needs to be stated.

Page 11, line 12: Why add a constant 1 dB random noise to the PIA but use an SNR dependent noise for the reflectivities? The NRCS should be converted to a reflectivity and use the same SNR based noise that the profile uses. Or justify where this 1 dB number comes from.

Figure 7: colorbars have no units.

Page 12, line 25: 'defined as the antenna-weighted PIA'. I don't think this is stated correctly. I believe you are referencing the PIA of the precipitating or cloudy part of the antenna pattern while neglecting clear sky. When I read ‘antenna-weighted’ that seems to include the clear sky. If it did include the clear sky the SRT would not underestimated the PIA. Defining quantities through equations could eliminate the ambiguity.

Page 13, line 15: The conclusion here regarding minimum LWP sensitivity is a function of your assumption of 2K Tb uncertainty. I think you ought to state that explicitly as there is no reason a radar with better Tb precision cannot be designed (which in practice would likely mean sacrificing minimum reflectivity sensitivity). For example Lebsock and Suzuki (2016) show for this RICO case that 10 gmˆ-2 TWP sensitivity should be achievable with different Tb uncertainty assumptions.

-Reviewed by Matt Lebsock-

REFERENCES:

Lebsock M.D. and Kentaroh Suzuki, 2016: Uncertainty Characteristics of Total Water Path Retrievals in Shallow Cumulus Derived from Spaceborne Radar/Radiometer Integral Constraints. J. Atmos. Oceanic Technol. 33, 1597–1609, doi: 10.1175/JTECH-D-16-0023.1.

Snodgrass, E. R., L. Di Girolamo, and R. M. Rauber (2009), Precipitation characteristics of trade wind clouds during RICO derived from radar, satellite, and aircraft measurements, J. Appl. Meteorol. Climatol., 48, 464–483, doi:10.1175/2008JAMC1946.1.

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